Automated Patient Care Documentation: What's in it for us? An Expert System Emergency Drug Card Printout

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ABSTRACT

This article summarizes experiences to date for a collaborative approach, utilizing systems analysis and decision support methods, to design, develop, and implement automated patient centered documentation. Current manual methods for retrieving patient centered data for treatment activities and evaluation of practice are laborious, frustrating and often uneventful. Accessing specific patient information in an arrest or emergent situation, in the hospital and out patient clinical setting, is fraught with difficulties of data and information availability, reliability, legibility, integrity, security, and obsolescence. Treatment decisions made during an arrest or emergent situation, whether for an in-patient or clinical out patient, utilize Advanced Life Support guidelines and also may vary based on the heuristics of the lead practitioner on duty at the time. Walking the informatics talk of "managing and processing data to information to knowledge" lead to standardization for best practice of emergency drug calculations and treatments (1).

An expedient and reliable method for retrieving patient specific data to calculate 26 medications, 3 treatments, and upwards of 40 criteria to consider during an arrest or emergent situation was achieved and implemented, as a by product of height and weight charting, across most all patient care areas at Primary Children's Medical Center in Salt Lake City Utah.

INTRODUCTION

Driving market forces to decrease costs and measure outcomes is accepted justification for the implementation of automated patient centered clinical information and documentation systems. Implementation of computerized clinical information and documentation systems has spurred nurse managers and staff alike to ask, "What's in it for us?" This question is not meant to be self serving but is raised along with current concerns for RN cutbacks and mandates by organizations to hire increased proportions of UP's (unlicensed assistive personnel).

Primary Children's Medical Center (PCMC) , a subsidiary of Intermountain Health Care Hospitals Inc., is a 232 bed tertiary pediatric acute care hospital and teaching facility in Salt Lake City, Utah. A wide range of specialized pediatric services are provided to children and their families across Utah, Wyoming Nevada, Idaho and Montana. In 1994, PCMC had 9,219 admissions and 154,364 out patients visits to 32 clinics and the Emergency department. This hospital also serves as one of the primary teaching centers for the University of Utah.

Primary Children's is implementing the HELP system as the Clinical Information System. Since 1991, these modules have been implemented: ADT; Order Entry for Pharmacy, Medical Imaging, Laboratory and Blood Ordering; Results Review for Medical Imaging, Laboratory, Microbiology; Nursing Care Plans, and Height/Weight and BSA charting; Dictated text review and the Physician's interface. Terminals are placed at the bedsides in the intensive care units, central clerk stations, nursing pods, in outpatient clinics, and all ancillary departments. Enhancements to the software to facilitate pediatric vital signs, intake and output, other measurement charting, medication charting and clinical reports are being done on site.

When the nursing staff were asked to chart heights and weights, they responded with "What's in it for us?" Replying that the data would be instantly and concurrently available to the integrated Pharmacy and Lab applications for medication and lab value calculations, BSA's would be auto calculated and updated, and Fahrenheit to Centigrade, pounds to kilograms, and inches to centimeters would be auto converted, was barely impressive. They saw charting heights and weights in the computer as redundant work with little reduction in effort on their part. Many of the staff began to ask, "If the computer can calculate appropriate medication dosing for the pharmacist's based on age data from ADT and height/weight and BSA data from Nurse Charting applications, why can't the system

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calculate and print the Emergency Drug Card (EDC) for us?"

If this enhancement to calculate and print the EDC could be implemented, six major benefits were identified to be possible by the general nursing staff computer user group and the hospital code committee members. The benefits identified were:

1. Time savings of two nurses doing the EDC calculations.
2. Improved data and information legibility, availability, integrity and reliability.
3. Communication of standardized logic and rules agreed upon by clinicians across patient care areas for dosing.
4. Expedited availability of data and information related to the real time of admission.
5. Capture and storage of data and information for eventual outcomes analysis.
6. Expedited communication of changes in clinical practice for drug dosing across patient care areas by altering the rules and logic in the application.

A possible negative effect identified by the general nursing staff and code committee was that the staff would forget how to do the EDC calculations if they relied on the computer to do it for them.

Figure 1.

Pediatric ICU Drug Card (Original manual version)
Name:_____ Wt:_____ BSA:_____
EBV:_____ 10% EBV:_____
Full Maint:_____
1:1 Conc_____/100cc _____50cc
.1:1 Conc_____/100cc _____50cc
2:1 Conc_____/100cc _____50cc
5:1 Conc_____/100cc _____50cc
Conc_____/100cc _____50cc

Epi (.1cc/kg) _____cc
Bicarb (1 mEq/kg) _____mEq _____cc
M.S. (.1mg/kg) _____mg _____cc
Valium (.1mg/kg)_____mg _____cc
Narcan (.01mg/kg)_____mg _____cc
10% Calcium Gluconate (.3cc/kg)_____cc
Atroping (.02mg/kg)_____mg _____cc
(Vials .4mg/cc)
_____cc
(abboject .1mg/cc)
Lidocaine (1mg/kg bolus)_____mg _____cc
Lidocaine drip 10:1 Conc _____/100cc _____50cc
Fentanyl drip (1:10 ug/kg/hr) _____

INTUBATION DRUGS:
Succinylcholine (1-2mg/kg)_____mg _____cc
Versed (0.1mg/kg) _____mg _____cc
Atropine (0.01mg/kg) _____mg _____cc
Sig _____ Sig _____

CURRENT SYSTEM

A team of collaborative key players identified the opportunity to automate the hand calculated EDC, which is used during patient arrests and emergent situations. Historically, EDC's only were calculated by nurses admitting patients into the intensive care units (See Figure 1). Since children admitted to this tertiary care facility have the potential to deteriorate clinically quite rapidly, the staff from the general nursing units choose to calculate EDC's on all admissions, not just those admitted into the intensive care units.

The new house wide version of the manual EDC grew to include medications used for patients experiencing seizures, included formulas for individual drug and treatment calculations, criteria for dosing and formulas, and it included dose ranges and subsequent dosage calculations (See Figure 2). Thus, the nurse who didn't have all this information committed to memory had instant reference data on the form.

It is generally accepted practice for pediatric nurses to calculate dosages, prior to administration, for any medication to be given to a pediatric patient, based on the patient's weight in kilograms or BSA. In specific instances, the calculations done by the first nurse are verified by the second nurse. In the PICU at PCMC the old version, of the manual EDC, was a temporary worksheet filled out prior to or on admission of a patient and taped to the head of the bed until the patient was transferred out of the PICU. Formulas for calculation were not on the form and the process of filling one out was a purposeful exercise and test of the nurse's ability to recall formulas and compute the correct answer.

As you can see, in Figure 2, the new manual EDC version grew to be a 2 sided, 4 inch by 11 inch form, which required 39 calculations and 42 criteria to consider in doing the calculations. The staff outside of the ICU's were overwhelmed by the number of calculations and criteria that needed to be taken into consideration. In doing this new task, the floor nurses found themselves spending 15 to 30 minutes per patient calculating and verifying the EDC. To beat the new system, the staff made laminated copies of cards with the answers filled in for various weights, then transcribed the answers to the new cards. A single copy of the EDC was kept at each patients bedside. These cards were only worksheets, updated weekly for growing infants, and not saved as part of the permanent record.

FIGURE 2. PCMC Emergency Drug Card (new manual version)

Name:_____ Weight _____
Admit Date:____ Full Maint:_____ Update Date:_____
24 Hr Maint fluid: _____ml = _____ml/hr
(100ml/kg 1st 10kg +50ml/kg 2nd 10kg +25 ml/kg for kg>20)

EBV (80ml/kg) _____ml 10% of EBV _____ml

Drug & Cct	Dosage/Kg	Final Dosage
Epinephrine		
1:10,000	1st dose IV, IO 0.01mg/kg (0.1mg/kg)	_____ml IV,IO 1st dose
1:1,000	1st dose ET 0.1mg/kg (0.1mg/kg)	_____ml ET 1st dose
1:1,000	Subsequent IV,IO,ET 0.1mg/kg (0.1ml/kg)	_____ml Subsequent doses
Atropine	.02mg/kg minimum .1mg	
.1mg/ml	Max single dose 1 mg	_____ml(.1mg/ml)
1mg/ml	Max total dose 2 mg	_____ml(1mg/ml)
Glucose		
25% (250 mg/ml)	≤4mo 2-4ml/kg D12.5	
50% (500mg/ml)	>4mo 2ml/kg D25 ≥50kg 50ml D50	_____ ml
Naloxone (Narcan)		
.4mg/ml	<20kg 0.1mg/kg ≥20kg 2mg	_____ml
Calcium Gluconate		
100mg/ml (periph)	100mg/kg max 2000mg(20ml)	_____ml
Calcium Chloride		
100mg/ml (central)	20mg/kg max 500mg (5 ml)	_____ml
Sodium Bicarb		
.5mEq/ml (4.25%)	≤5kg 2ml/kg of .5mEq/ml	____ml(.5mEq/ml
1mEq/ml (8.4%)	>5kg 1ml/kg of 1mEq/ml) to max 50mEq 8.4% sol	____ml (1mEq/ml)
Lidocaine		
20mg/ml	1mg/kg up to 100mg max	_____mg IV,IO,ET
Adenosine (Adenocard)		
3mg/ml	200mcg/kg = .2mg/kg fast IV push - may repeat x 3 max single dose 12 mg	_____ml

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NEW SYSTEM

"The most important thing to know regarding your user is that he is not interested in using your product. He is interested in doing his work, and your product must help him do it more easily" (2).

The general nursing staff felt that most anything would be more efficient, less intimidating, and less error prone than the new manual version of the EDC. Data entry errors, transcription errors, calculation errors, lack of clarity and simplicity, getting manual updated forms into circulation and manual outdated forms out of circulation, a quick and easy way to calculate and print the EDC, and more information is not necessarily better information were some of the issues which needed to be addressed when computerizing this manual form of the EDC.

Structured English was used to develop internal logic for the computerized version of the EDC. The external logic was derived from the manual versions of the EDC, the written guidelines to calculate dosages, the general nursing staff computer user group, the literature, and the hospital wide Code Committee's recommendations (See Figure 3). Approximately 1800 lines of code later, the nursing staff was able to input heights, weights, and print the Emergency Drug Card.

The original screen design, to input heights and weights, was modified to represent pediatric end users specifications. The number of keystrokes for entering heights and weights decreased from 11 to 7 keystrokes. The number of screens in the screen flow increased from 2 to 3. The calculations for the computerized EDC occur in the background (See Figure 4). After entering the height and weight, a function key is pressed to calculate and print the computerized EDC. The additional screen presents the user with an aggregated view of previously entered height and weight data.

Figure 3. Structured English for the EDC

Logic for Emergency Drug Card calculations
(This will vary for each medication, two examples are given)

IF the medication is **Sodium Bicarbonate**
  and **IF** the patient weight is ≤ 5 kg
    THEN give 2ml/kg of $NaHCO_3$ of (4.25%) 0.5mEq/ml solution
  ELSE IF the patient weight is < 50 kg
    THEN give 1ml/kg $NaHCO_3$ of (8.4%a) 1.0 mEq/ml solution
  ELSE IF the patient weight = 50 kg
    THEN the maximum dosage of $NaHCO_3$ is 50 mEq or 50cc's of (8.4%) 1.0 mEq/ml solution.

IF the medication is **Glucose**
  and **IF** the patient age is ≤ 4 months
    THEN give 2-4mg/kg of D12.5% solution
  ELSE IF the patient age is > 4 months
    THEN give 2ml/kg of D25% solution
  ELSE IF the patient weight is ≥ 50 kg
    THEN give 50 mls of D50% solution

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IMPLEMENTATION

The general nursing staff computer user group and house wide Code Committee was continually involved in designing and testing of the computerized EDC and height and weight data entry screens. When the software was approved by this group, it was installed and tested in the live environment. The general nursing staff computer user group felt the application was easy enough to use, so they could train their own departmental staff at the bedside or pod terminals. Time was not of the essence for training because charting heights and weights in the computer would not eliminate charting heights and

weights on the bedside flow sheets. What it would eliminate was the EDC manual calculations and the pharmacists transcribing and entering the height and weight into the pharmacy application. Some of the members of the nursing computer user group utilized the members of their Shared Governance Practice Councils to assist with training in the clinical areas. A step by step instruction sheet was created and distributed to all the nursing staff by members of the nursing computer user group. Implementation occurred house wide, except for the Neonatal ICU, Emergency Department and Surgical Services. The Code Committee wrote and distributed policy and guideline information to answer the nursing staff concerns on these issues:

1. Who may sign-on to the computer and chart heights/ weights and print the EDC?
2. How soon after admission is this expected to be done?
3. What do the double signatures on the EDC mean?
4. Is the EDC part of the permanent record?
5. Where will the EDC be kept and how many copies are needed?
6. How often will the EDC need to be updated?

The answers to these questions were distributed with the instructions.

Figure 4. Computerized Printout of the EDC

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Emergency Drug Card

Wt 15.6kgMaint fld1280ml/24=53.3ml/hr EBV(80ml/kg) 1248ml10%EBV124.8ml

DRUG/ CCT	DOSAGE/KG	FINAL DOSAGE
Adenosine (Adenocard) 3 mg/ml	**max/dose 12mg, fast IVP** may repeat 3x 0.2 mg/kg	1.0 ml
Atropine 0.1mg/ml 1 mg/ml	min 0.1mg, max 1 mg, total max 2 mg 0.02 mg/kg 0.02 mg/ml	3.1ml (.1mg/ml)
Bretylium 50 mg/ml	50 mg/kg - may double on 2 nd dose	1.6 ml
Calcium Chloride 100 mg/ml (central)	max 500 mg (5 ml) 20 mg/kg	3.1ml
Calcium Gluconate 100 mg/ml (periph)	max 2000 mg (20 ml) 100mg/kg	15.6 ml
Cardioversion	< 50 kg ≥ 50kg	
	0.5 joules/kg 200 joules	7.8 joules 1st
	1 joules/kg 400 joules	15.6 joules 2nd

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Sig_____ Sig:_____

Parents phone #:_____

Drug Allergies: No Known Allergies

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DISCUSSION

Throughout this process of software development and implementation, it was important to separate and clarify people issues from the computer issues for the nursing staff. Assumptions about the benefits of computerization were that with computerization nurse's attitudes towards computerization will improve, time and therefore costs will be saved and the quality of documentation will improved (3). Including the general nursing staff on the testing side resulted in a greater achievement of benefits, such as reduction in documentation time, training time, and helped to promote buy-in for using the system (4). Staff performed to expectations, as expectations for software and changes in people processes were planned for and included in development, testing, and training.

A need for various numbers of copies to be printed, depending upon the location of the patient, lead to an enhancement to the data entry screens almost immediately after implementation. Including the staff in the testing process helped to bring the people issues into the development process. Staffs understanding that the decision rules within the applications were derived from standardized best practice policy, protocols, or guidelines identified and agreed upon by clinicians from all areas within their organization promoted usage and rapport. The more the clinicians used the system the more it was their idea on how to make enhancements. It was very important to be in the hallways and be tuned in to the small talk in order to match the development of the systems to meet our users needs.

FUTURE PERSPECTIVE

Initially, not all departments wanted to use the EDC. Some jumped on board quickly, as they saw how easy it was and developed trust for the computer to generate correct calculations. So many clinicians are taught to do their own assessments and calculations and to double check everyone else's, especially in the field of pediatrics. Other departments have developed their own methods and systems. Therefore, personal investments in letting go and moving to the house wide system is still not a priority.

Ongoing development of the logic and criteria to meet the staffs needs will be easier now, as will updating the logic and criteria coincidentally with changes in practice. Data becomes information when decision support methods invoke best care guidelines and protocols, only then will performance measurements become intrinsic to clinical information systems and enticement to input patient data become rudimentary.

Buying into the bigger picture for timely outcomes measurement, simplified by access to extensive amounts of archived and coded data, will be valued if care givers perceive a net reduction in effort and leverageable clinical infomation.

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